

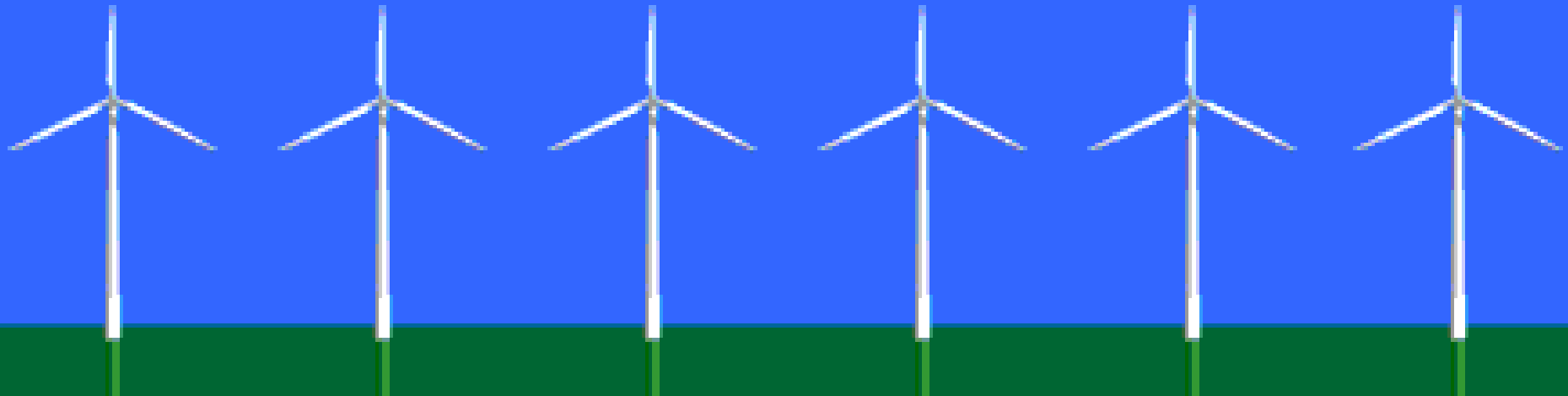


Wind 101

An Introduction to Wind Energy

Richard Lawrence

Cape & Islands Self-Reliance



“Windmills have fascinated us for centuries and will continue to do so. Like campfires or falling water, they’re mesmerizing; indeed, entrancing.”

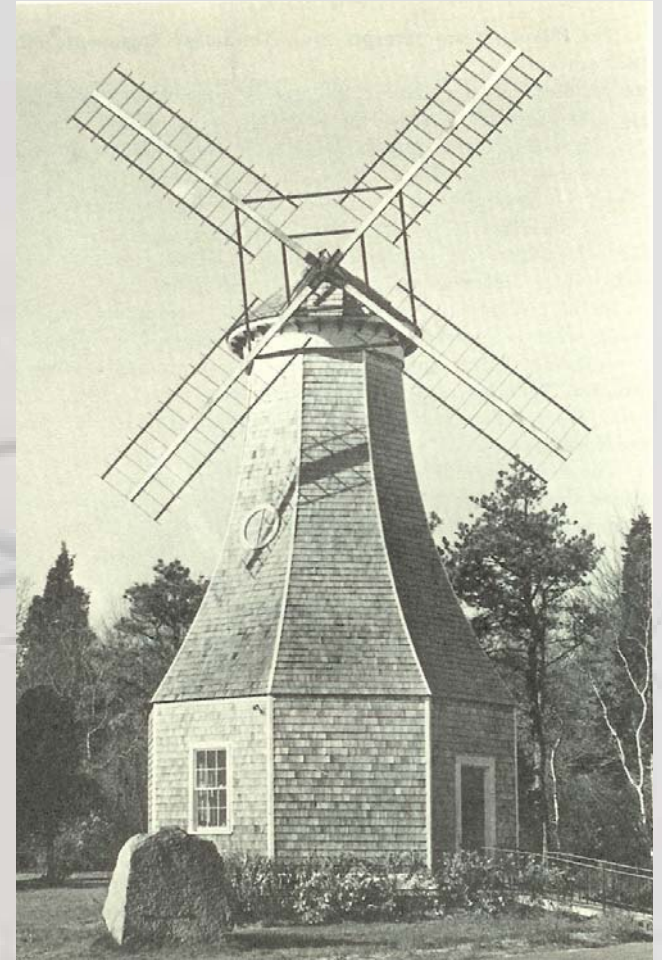
Paul Gipe, Wind Power for Home, Farm, & Business



Wind Energy is in our history



The pilgrims arrived under the power of wind. Cape Cod was home to the first windmill in America. Wind helped fuel our country's early economy.





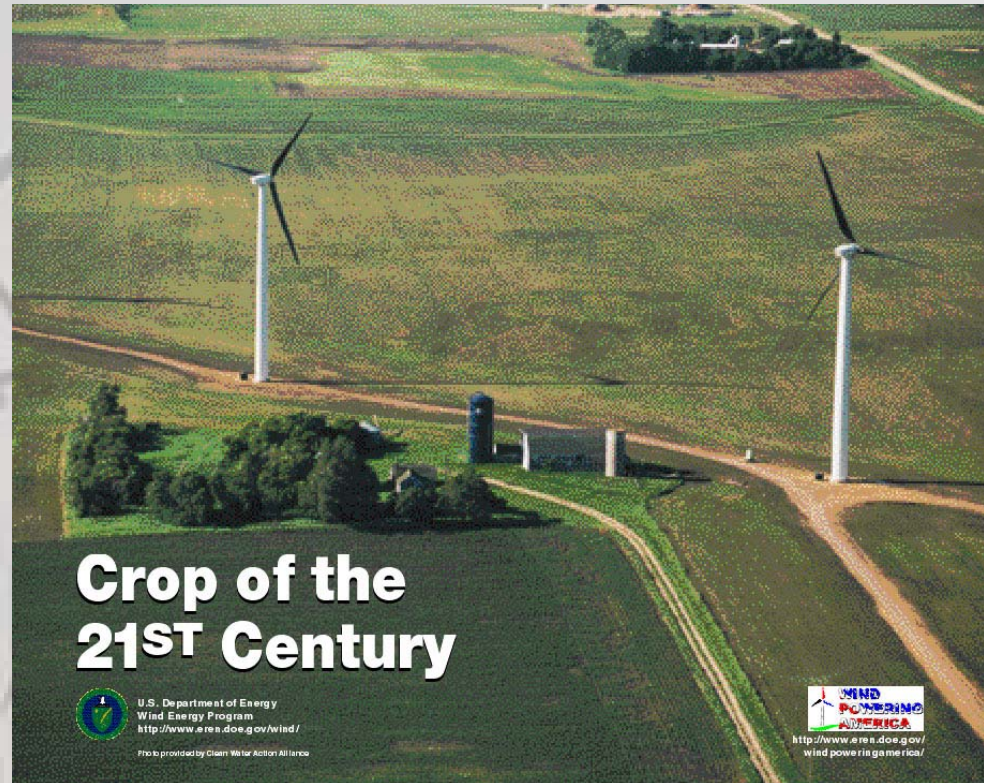


Fighting windmills also has a long history!



Drivers for Wind Power

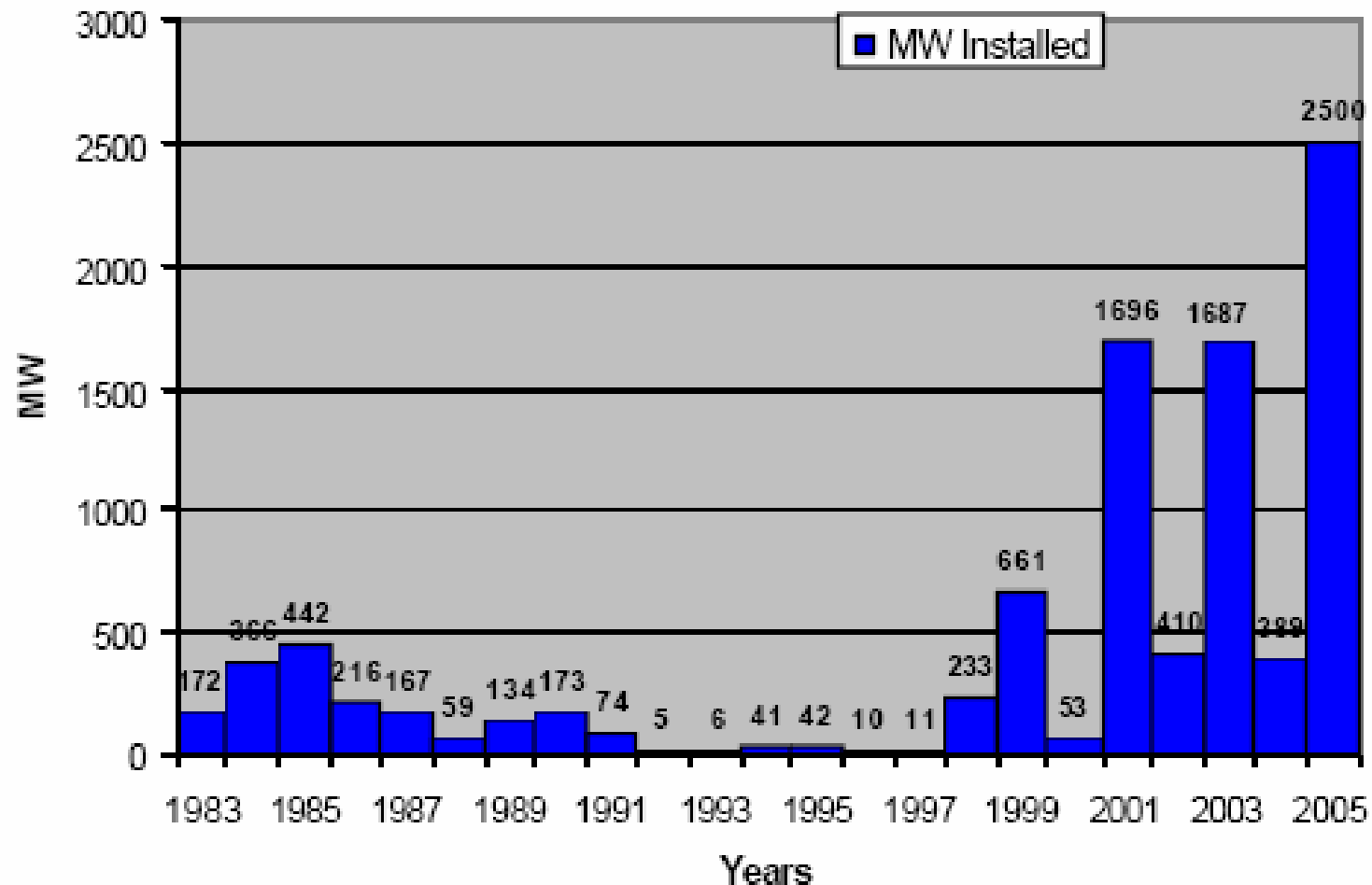
- Rising Fuel Price and Uncertainty
- Declining Wind Costs
- Federal and State Policies & Incentives
- Local Economic Development
- Environmental Stewardship
- Energy Security
- Consumer Demand



US Capacity is Growing

(In fits and starts due to lack of consistent long term federal policies and diverse state policies)

U.S. Annual Capacity Additions



Types of Wind Turbines



Small (≤ 10 kW)

- Homes
- Farms
- Remote Applications

\$5,000-\$50,000



Medium (10-250 kW)

- Village Power
- Hybrid Systems
- Distributed Power

\$50,000-\$500,000



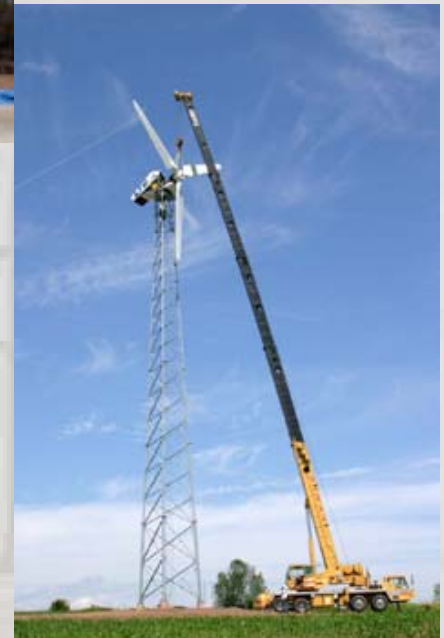
Large (250 kW – 5 MW)

- Central Station Wind Farms
- Distributed Power

\$500,000 - >\$5,000,000

Small & Medium Turbines

- Micro
 <1.25 m (4 ft) rotor
 diameter
- Mini / Cabin-size
 1-3 m (3-10 ft) rotor
 diameter
- Household
 4-10 m (13-33 ft) rotor
 diameter
- Medium
 10-60 m (33-200 ft) rotor
 diameter



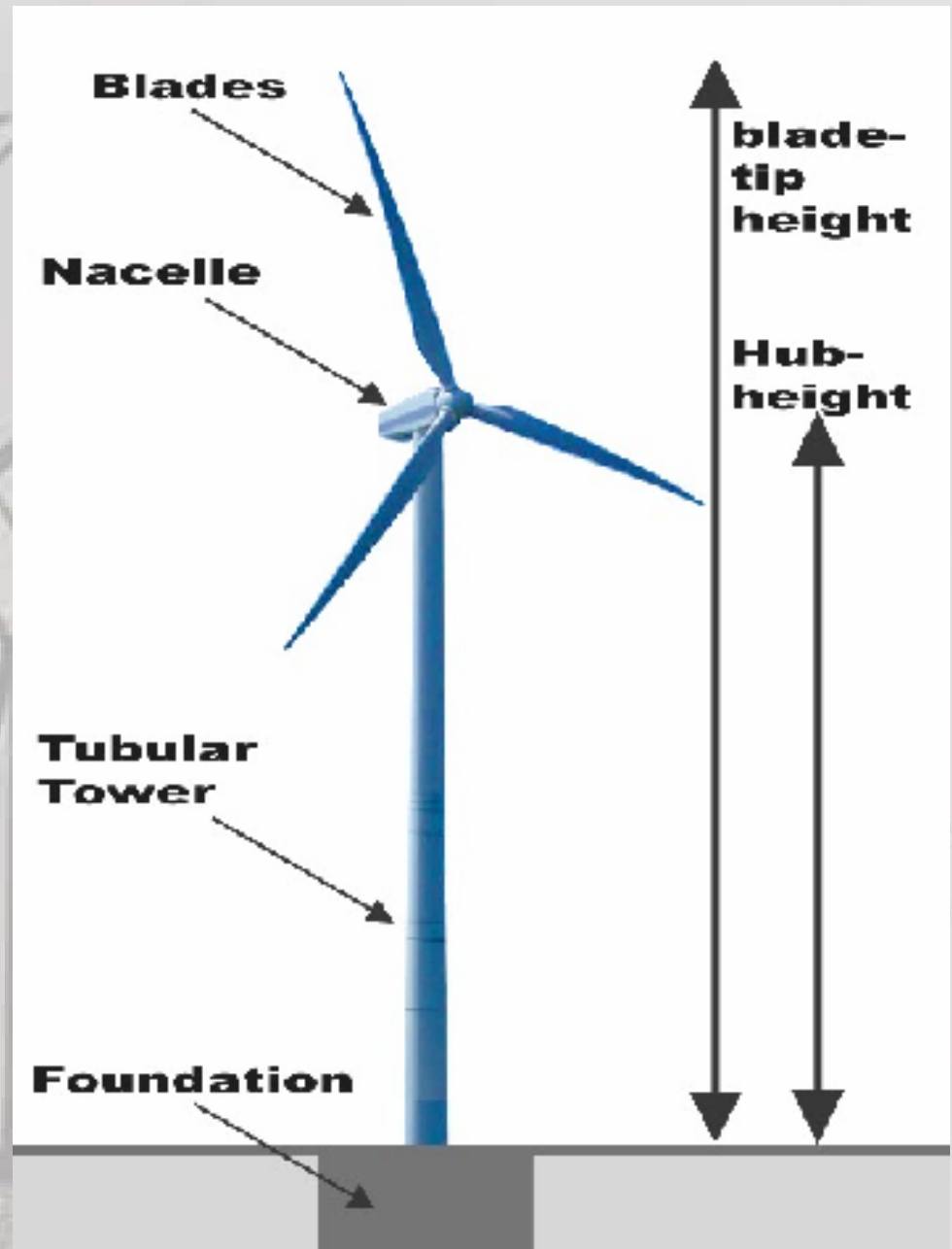
Wind Power Today: *Design*

- Horizontal axis
- 3 bladed
- Upwind
 - Active yaw
- Tubular tower
- Variable/or
constant speed



Large Wind Turbines

- Hub height :
 - 160' - 260'
- Blade tip height:
 - 240' - 390'



Wind Turbine Perspective

Workers



Blade
112' long

Nacelle
56 tons

Tower
3 sections



Wide Sweep



231 ft.

A photograph of a large white wind turbine with three blades. A red line with circular endpoints at the tip of one blade and the center of the hub indicates the sweep length. The background shows a clear blue sky and other turbines in the distance.

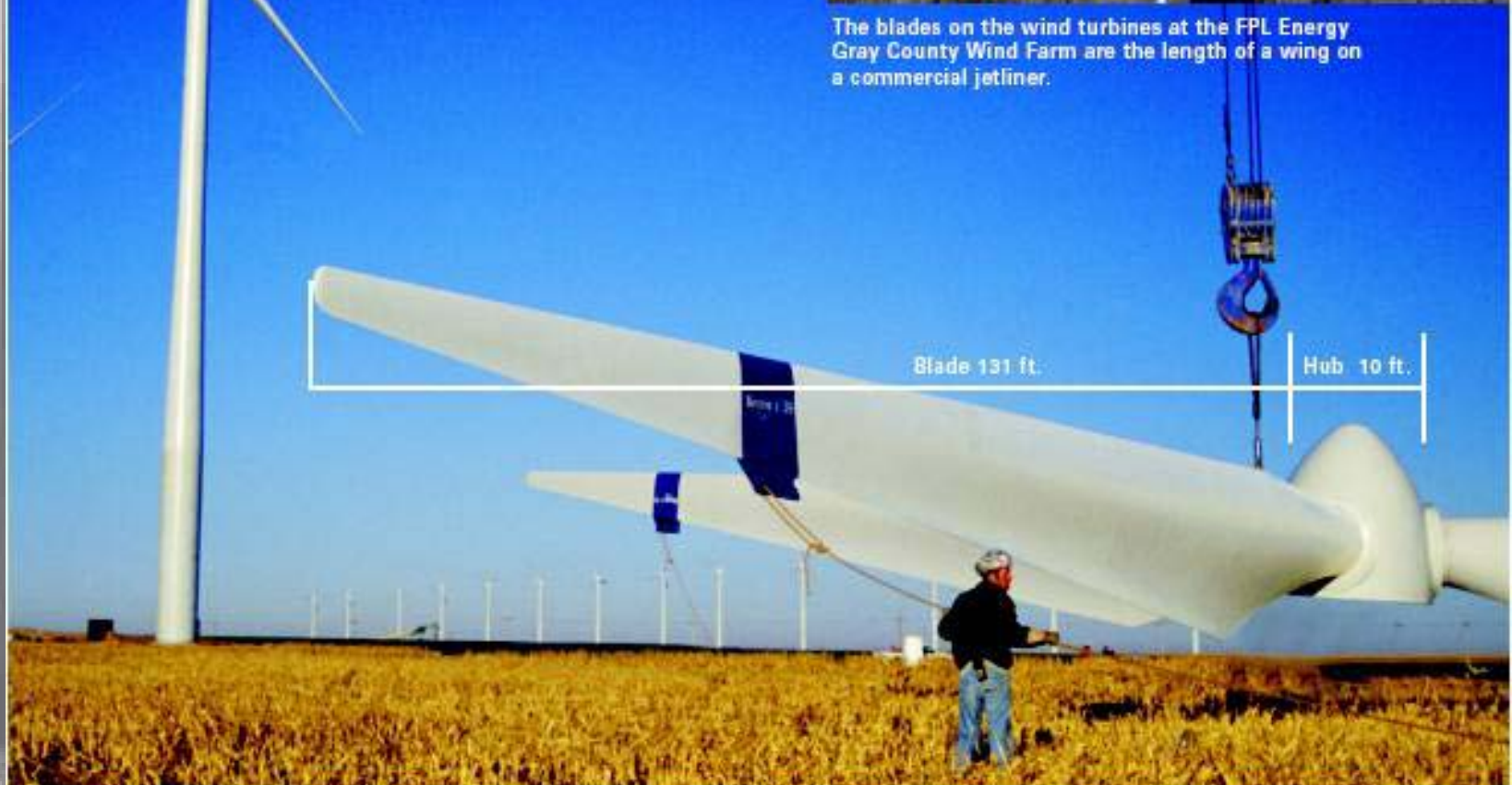


211 ft.

A photograph of a white Boeing 747 aircraft on a runway. A red line with circular endpoints at the tip of the upper wing and the bottom of the fuselage indicates the sweep length. The aircraft has the number '747' on the tail and 'Boeing 747-400' on the fuselage.



The blades on the wind turbines at the FPL Energy Gray County Wind Farm are the length of a wing on a commercial jetliner.







Similar Structures

- **Utility Poles**
- Radio Towers
- Cell Phone Towers
- Water Towers



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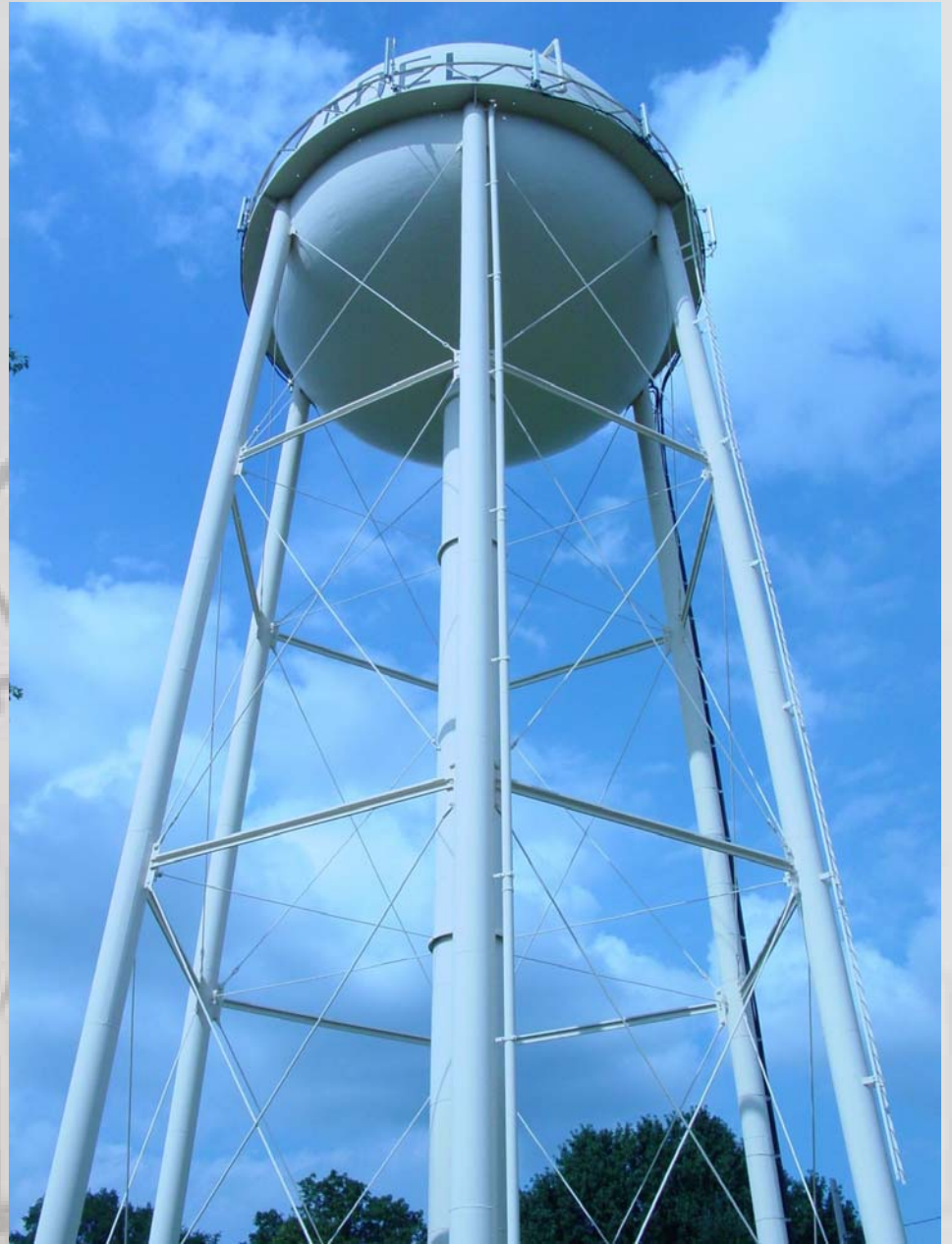
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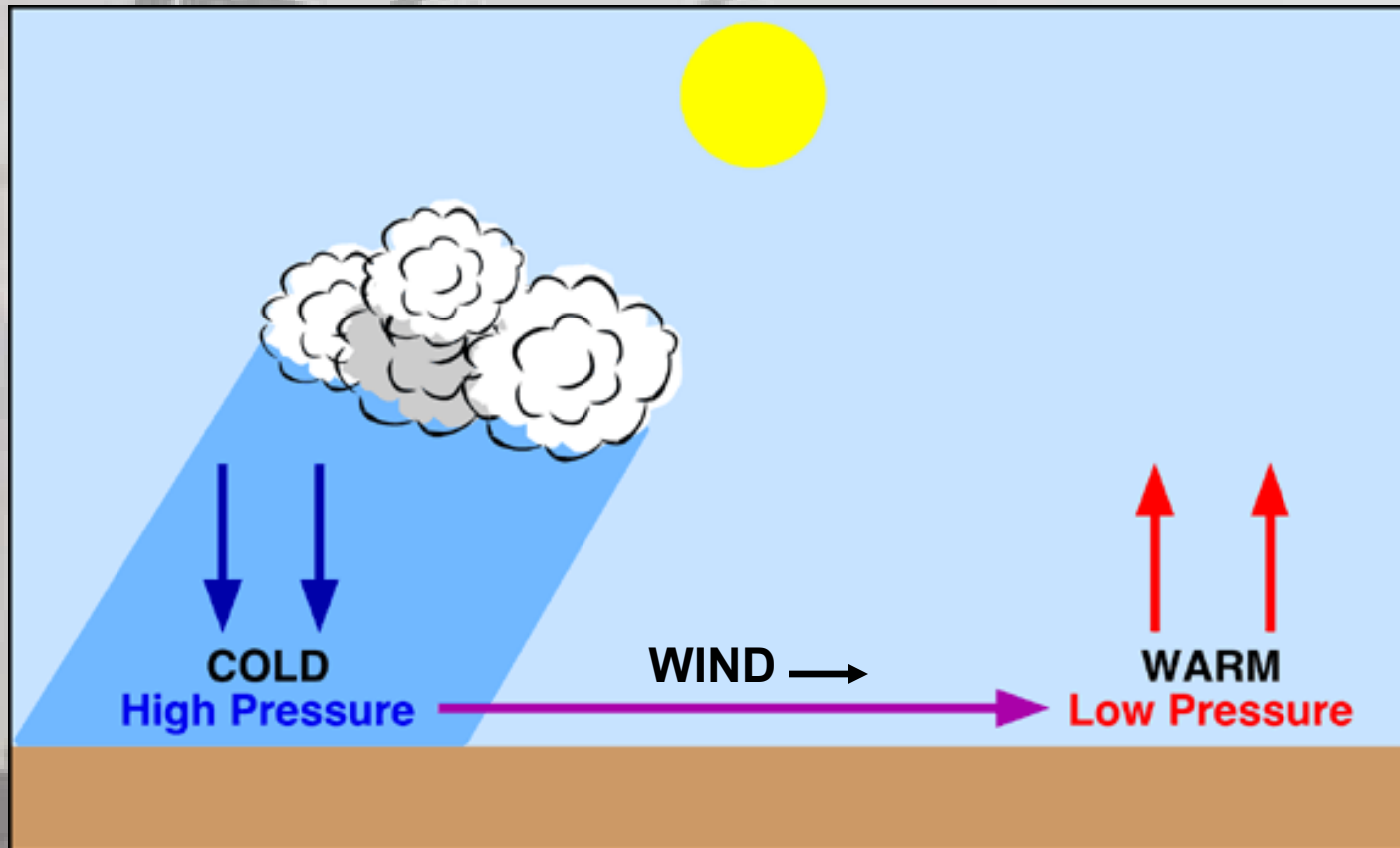
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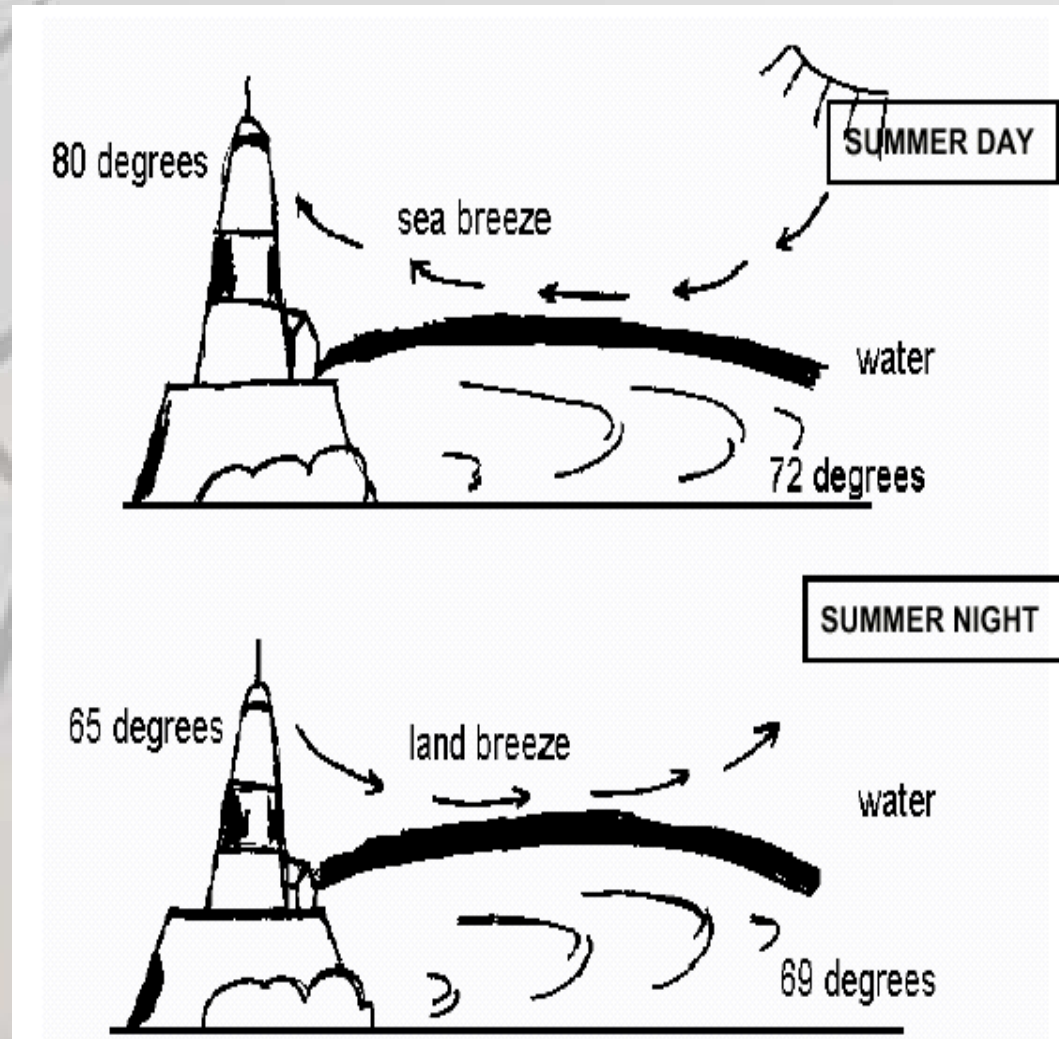
How Wind Works

Wind energy is created by uneven heating of the earth's surface.



Local Land-Sea Breezes

- Land-sea breezes created by temperature differentials between land and water
- Winds also stronger near shore because of long unobstructed fetch
- Cape Cod has a “dual sea breeze”





Wind Resource

Mean Speed

mph m/s

< 12.3	< 5.5
12.3 - 13.4	5.5 - 6.0
13.4 - 14.5	6.0 - 6.5
14.5 - 15.7	6.5 - 7.0
15.7 - 16.8	7.0 - 7.5
16.8 - 17.9	7.5 - 8.0
17.9 - 19.0	8.0 - 8.5
19.0 - 20.1	8.5 - 9.0
20.1 - 21.3	9.0 - 9.5
> 21.3	> 9.5

